DACW-33-85-D-0011 Delivery Order 0007
Land Seismic, Westfield River
Westfield, MA

FILE COPY

ATLANTIC TESTING LABORATORIES, LIMITED

Sustaining Member—N.Y.S. Society of Professional Engineers

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December 20, 1985

U. S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254-9149

Attn: Mr. Richard Reardon

Re: Land Seismic, Westfield River
Westfield, MA
Contract DACW-33-85-D-0011
Delivery Order No. 0007

Gentlemen:

In accordance with Delivery Order No. 0007, dated 16 October 1985, attached is one copy of our seismic investigation report for the Westfield River, Westfield, MA.

By copy of this letter, we are also transmitting two copies of this report to Mr. John Hart.

If you have any questions or comments, please do not hesitate to contact our office.

Respectfully submitted,

Spencer F. Thew, P.E./L.S.
President

SFT/smf

cc: Mr. John Hart (2)

encs.

SECTION 1

CONTRACT DACW-33-D-85-D-0011
CONTRACTING OFFICER:
Edward D. Hammond, LTC, CE
28 June 85

WORK ORDER NO. 0007

16 October 85

SEISMIC INVESTIGATION
WESTFIELD RIVER
WESTFIELD, MA

PREPARED FOR: U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254-9149

PREPARED BY: Theresa A. Beddoe, Hydrogeologist
Atlantic Testing Laboratories, Limited
P. O. Box 29
Canton, NY 13617

November 26, 1985

ATL Report No. CD007-1-11-85

SECTION 2

TABLE OF CONTENTS

SECTION 3

SCOPE OF INVESTIGATION

Survey and exploration instructions, which were provided by the Army Corps of Engineers, New England Division, follow. The subsurface investigation program included about 4,200 feet of seismic survey lines required to determine depths to bedrock along a proposed dam alignment.

Work under this delivery order consisted of locating three seismic lines which traversed the Westfield River Valley and three lines perpendicular to these. Horizontal and vertical surveying techniques were used to determine locations and elevations of points along the seismic lines and of various site features.

SCOPE OF WORK

GEB REQUISITION NO. 86-3-DACW 33-85-D-0011
DELIVERY ORDER NO. 0007
SURVEY AND EXPLORATION INSTRUCTIONS

PROJECT: Seismic Investigation for Westfield River Basin Study

SITE: Westfield River, Westfield, Massachusetts

PURPOSE: Seismic surveys are required to determine depths to bedrock along a proposed dam alignment.

1. SCOPE OF INVESTIGATION.

a. Seismic survey lines shall be performed for a total of about 4,200 feet as shown on Attachment No. 2.

b. Surveys shall be done to determine locations and elevations compatible with site features shown on the enlarged USGS quadrangle Attachment No. 3.

2. SITE CONDITIONS.

The proposed seismic line traverses the Westfield River valley as shown on Attachment No. 2. The majority of the land in the area of interest is relatively flat at about elevation 150 feet and rises at the abutments to about elevation 250 feet. Sands and gravels are anticipated which may exceed 100 feet in thickness.

3. RIGHTS OF ENTRY.

The Contractor is responsible for securing any rights of entry, approvals, permits, etc. necessary for the performance of the work.

4. COORDINATION.

Mr. James Blair, Corps of Engineers, 617-647-8396, shall be contacted five days prior to start of work and each work day to report on how work is progressing and approximate depth to bedrock is being encountered.

5. EXPLORATION NUMBERS.

The seismic lines accomplished shall be numbered sequentially in order of their completion. The numbers shall be shown on the plan of completed explorations.

6. GOVERNMENT REVIEW.

The Government will review the draft submittal as well as the completed work. Subsequent to such review, the Contractor shall accomplish any corrections which may be directed as the result of the Government review.

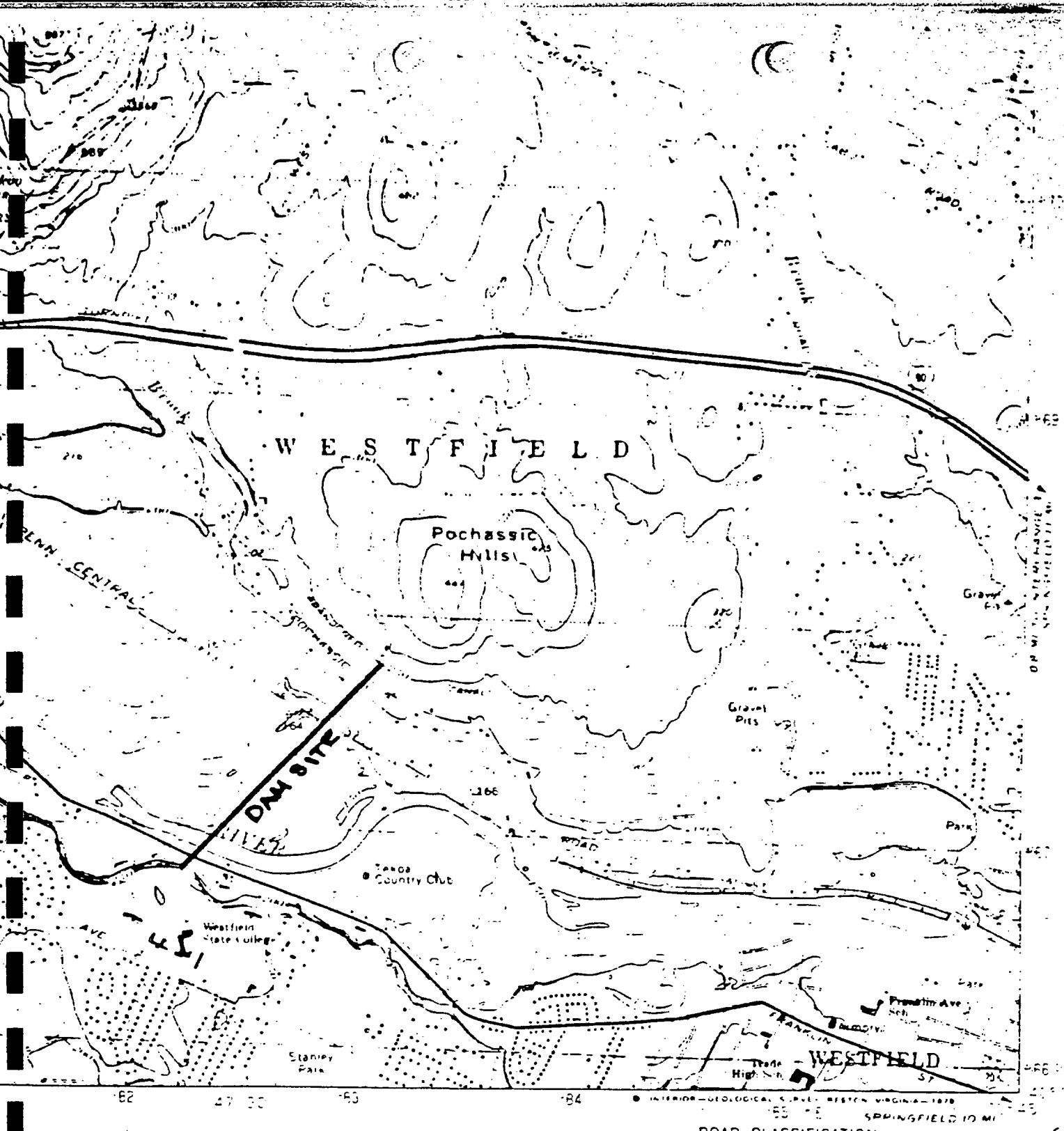
7. COMPLETION SCHEDULE

Services under this delivery order shall start no later than 21 October 1985. Duration of field work is estimated to be three work days. The geotechnical report shall be submitted in draft format for review by the Government, postmarked no later than seven calendar days after completion of the field work. Government review will take approximately ten calendar days from receipt of draft report. The final geotechnical report shall be submitted postmarked no later than seven calendar days after receipt of draft report including the action taken on possible comments.

8. QUALITY CONTROL.

You will be held responsible for the quality of the text and plates submitted and for all damages caused the Government as a result of your negligence in the performance of any services furnished under the contract.

Although submissions required by your contract are technically reviewed by the Government, it is emphasized that your work must be prosecuted using proper internal controls and review procedures. The letter of transmittal for each submission which you make shall include a certification that the submission has been subjected to your own review and coordination that the submission has been subjected to your own review and coordination procedures to insure (a) completeness for each displine commensurate with the level effort required for that submission, (b) elimination of conflicts, errors and omissions, and (c) the overall professional and technical accuracy of the submission. Documents which are significantly deficient in any of these areas will be returned to you for correction and/ or upgrading prior to our completing our review. Contract submission dates will not be extended if a resubmission of draft material is required for this reason.



ROAD CLASSIFICATION

Primary highway, all weather hard surface

Secondary highway, all weather hard surface

Light duty road, all weather, improved surface

Unimproved road, fair or dry weather

Interstate Route — U S Route — State Route

QUADRANGLE LOCATION

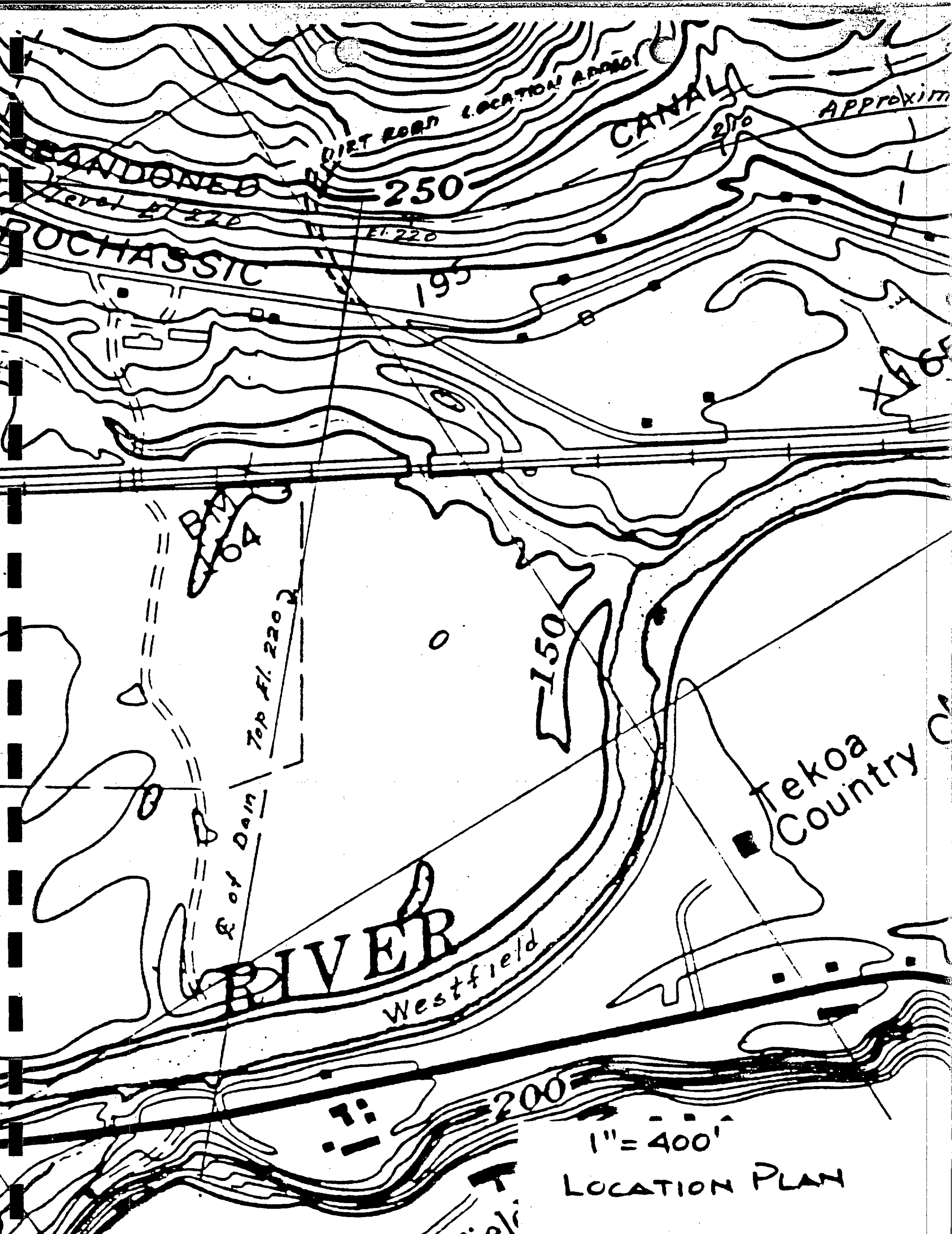
WORONOCO, MASS.
N4207.5—W7245/7.5

1967

AMS 6468 III NE—SERIES V814

TANDARDS
NIA 22092
AILABLE ON REQUEST

ATTACHMENT NO. 8



1" = 400'
LOCATION PLAN

SECTION 4

QUALITY CONTROL/ASSURANCE

a. General Statement:

The equipment and procedures used to perform the work and the investigation results are summarized in the report prepared by Weston Geophysical Corporation, which is included as Section 8 of this report.

b. Quality Assurance Certification:

I hereby certify that the referenced records, equipment and procedures were used to perform the subsurface exploration described herein. I also certify that the work was performed in a professional manner and meets the requirements set forth in the work order.

CERTIFIED 26 November 1985

Spencer F. Thew, P.E./L.S.

SECTION 5

SUMMARY OF ACTIVITIES

Date	Activity
11 Nov	Monday: Surveyors mobilized to the site
12 Nov	Tuesday: time on site 8:00 - 14:30 - Surveyors cleared property for right of access to private land on the west and east sides of the Westfield River - recon job for horizontal control - intermittent rain, rained out at 14:30
13 Nov	Wednesday: time on site 09:00 - 17:00 - Surveyors made arrangements for topographic enlargement at New England Blueprint Company in Springfield - gas company clears job, expect no problem with gas lines - Weston Geophysical obtained blasting permit - conduct safety meeting - Surveyors set up survey baseline and closed traverse - Seismic crew began seismic survey, 5 test holes completed for 800 feet
14 Nov	Thursday: time on site 08:00-16:00 - Surveyors finish horizontal control and level circuits - Seismic survey crew completed 1600 feet
15 Nov	Friday: time on site 09:00 - 17:00 - Surveyors obtain topographic enlargement at New England Blueprint Company in Springfield - Seismic survey completed (1600 feet) - alleged landowner on northwest side of road, Ms. Mary Priest, irate because of our presence on land whose access had previously been cleared with farmer on other side of road, Mr. Stevenson, who claimed ownership of the property on 12 November 85.

SECTION 6

SAFETY REPORT

WEEKLY SAFETY MEETING

NEDSO

Date held 11/12/85

THRU: Area Engineer, _____ Area

Time ~~10:00 am~~ 10:00 am

TO: Safety Office, NED

1. Weekly safety meeting was held this date for the following personnel:

Contract No. CD007 Contractor Atlantic Testing Labs

Conducted By Dana Drake All personnel present (Contr) Mark Blackey & Olaf Westfa
(Sub) Ed Aiken
(Govt) _____

Subjects discussed (Note, delete, or add):
EM 385-1-1, Section: _____

NA ~~Accident Prevention Plan~~

Individual Protective Equipment - ✓

Prevention of Falls - ✓

Back Injury, Safe Lifting Techniques - ✓

Fire Prevention - ✓

Sanitation, First Aid, Waste Disposal - ✓

Tripping Hazards - trash, hose, nails in lumber - ✓

NA ~~Staging, Ladders, Concrete Forms, Safety Nets -~~

NA ~~Hand Tools, Portable Power Tools, Woodworking Machinery -~~

NA ~~Equipment Inspection & Maintenance (Zero Defects) -~~

NA ~~Hoisting Equipment -~~

NA ~~Ropes, Hooks, Chains and Slings -~~

Electrical Grounding, Temporary Wiring, GFCI - ✓

NA ~~Lockouts for safe clearance procedures - electrical, pressure, moving parts -~~

NA ~~Welding, Cutting -~~

NA ~~Excavations -~~

Loose Rock and Steep Slopes - ✓

Explosives - ✓

NA ~~Water Safety -~~

NA ~~Toxic materials - hazards, MSDS, respiratory, ventilation -~~

Other - none

Prepared by Dana Drake Title L.S.

2. Forwarded. Exposure hours:
ATL 61.0
Weston 53.0
Geophys
Total 114.0 manhours on site

Signature _____
Resident Engineer

CF:

NED FL APP F: 251

SECTION 7

SURVEY FIELD NOTES

T - EA

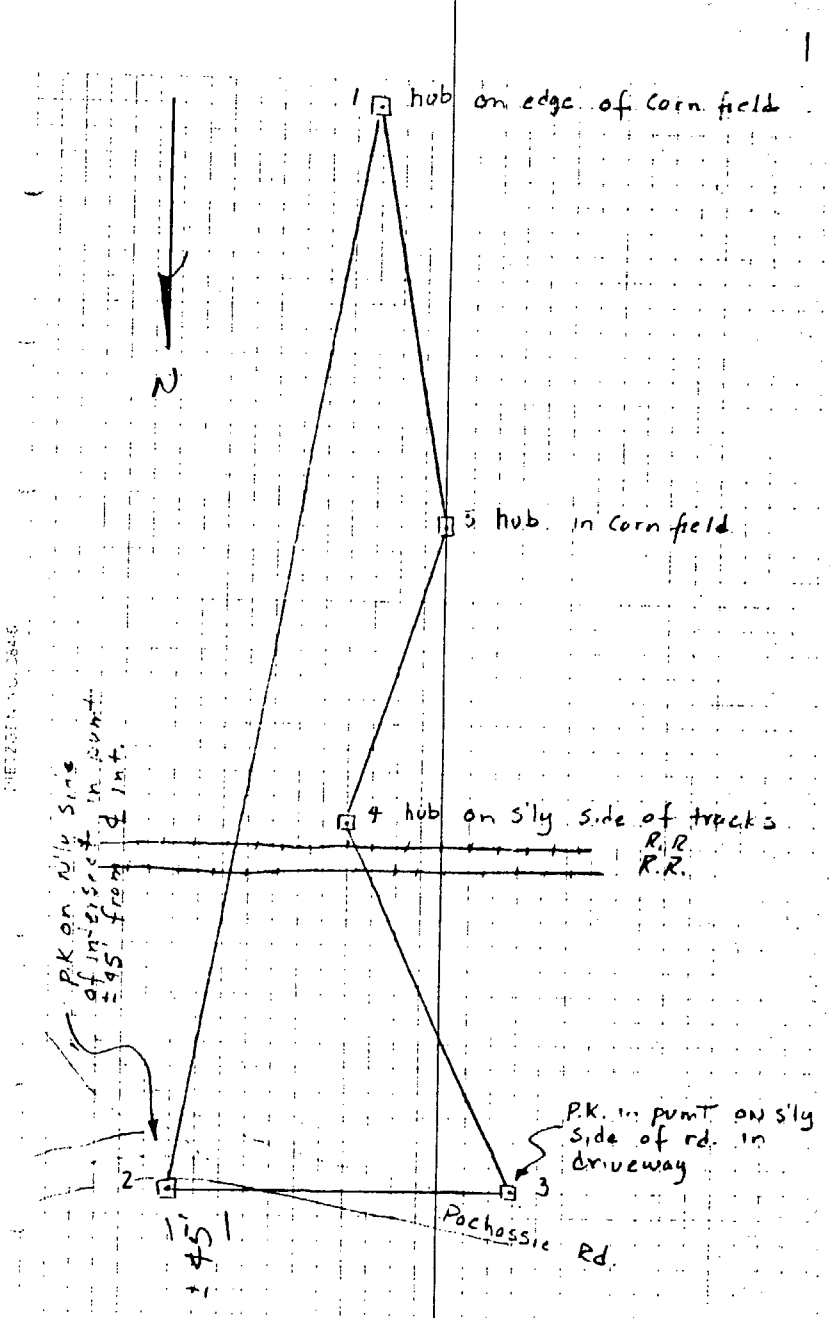
W - DLD

Nov. 12-15, 1985

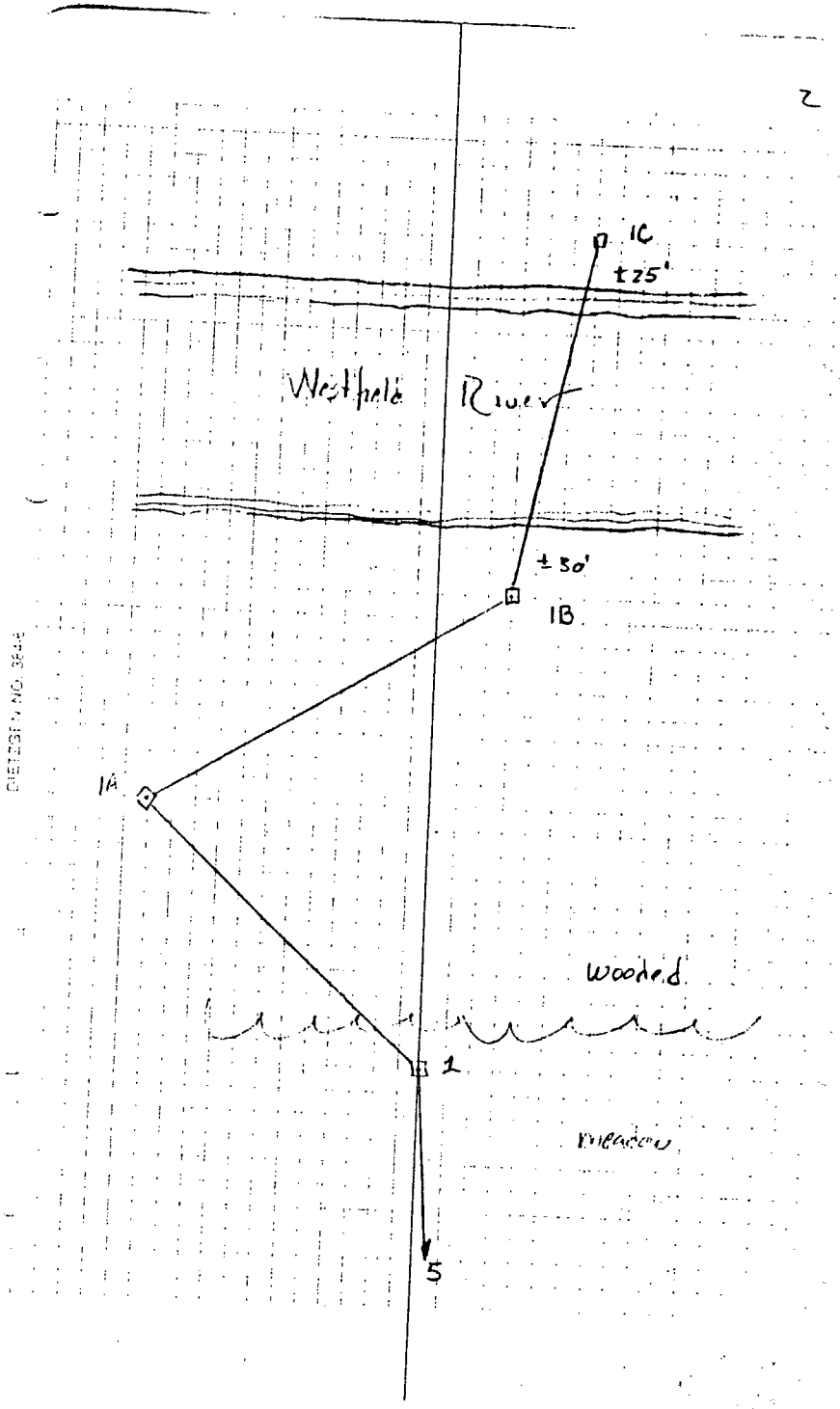
Westfield Seismic Survey

Westfield, Mass.

STA	H ∠	H.I.	V ∠	d	Elev.
	Brng?				
	Az: 5 → 4:		75°00'		
	05'00"				
	31°~~04~~57'				
5-1-2	15°32'~~57~~45"		89°22'12"	2966.~~34~~35'	
	297°21'36" ~~89°40~~				
4-5-1	148°40'48"		89°40'12"	1383.84	
	98°29'33"				
3-4-5	229°11'42"		90°38'12"	900.85'	
	132°46'18"				
2-3-4	66°23'09"		92°25'42"	801.08	
	160°18'30"				
1-2-3	80°09'12"		89°49'42"	575.56'	



Station	Angle		Dist	Rod	
	℄ @ 1-0-5 (6) 1A				
	H.I. =	hub ⌀1 +	4.85 =	162.31 + 4.85 =	167.16
4+00 (31)	272° 15'		~~+13~~ 213'	7.12	160.04
6+00 (32)	258° 05'		401'	7.58	159.58
8+00 (33)	252° 56'		593'	9.03	158.13
	H.I.		-D-	-R-	Elev.
	℄ @ 1A-0-1B (6) (7)				
	H.I. =	hub ⌀1 +	~~3+40~~ 340' =	162.31 + 3.40 =	165.71
2+00 (34)	123° 26'		78'	4.49	161.22
5 1A 1B (8)	0°		125'	5.70	160.01
0+00 (35)	349° 04'		136'	9.66	155.85
6 7 8	264° 49' 54"				
1A-1B-1C	142° 25' 00"		289.~~78~~ 77'	92° 34' 24"	
6 7	175° 12' 48"				
1-1A-1B	267° 36' 36"		125.05'	90° 26' 24"	
6	255° 03' 24"				
5-1-1A	127° 31' 42"		175.49'	9° 28' 36" ✓	



3

	H∡		-d-	-R-	
⊼@ 5-0-4					✓ 159.04
Line C		H.I. = 4.22 + hub#5 = 4.22+154.82 =			
STA 17+85 (43, ~~40~~)	37°28'		403'	2.90	156.14
STA 19+85 (41)	19° 05'		542'	5.0	154.04
STA 21+85 (42)	8° 34'		705'	4.60	154.44

Trig level across River H.I. = hub# ~~1B~~ 1C + 3.62 (1B 159.99+3.62) = 163.61

Vert ∡ 88°12'48" @ Top of hub

Elev 1C = 172.64

22° 12' 36"
1B-1C-1A 1°06'06"

4

⊼@ ~~2A~~ 2 0-~~2~~ 3

H.I. = STA ~~2K~~ + 5.41 = 195.22+5.41 = ~~170.63~~ 200.63 ✓

LINE XL1					
STA 4+00 (18)	11°33'		45'	6.78	193.85 (~~183.8~~)
STA 3+00 (19)	33°01'		92'	4.55	196.08 (~~166.08~~)

⊼@ 2A-0-2 (9)

H.I. = STA 2 + 3.72 = 195.72+3.72 = 199.94 ✓

LINE XL					
STA 2+00 (15)	353°30'		4'	5.2	193.74
STA 1+00 (16)	171°59'		95'	3.74	195.2
STA 0+00 (17)	169°37'		195'	3.0	198.14 (89°21'0")

LINE 1		Elev.	-D-	-R-	V∡
STA 0+00 (10)	59°12'	193.71	26'	5.23	~~193.71~~
STA 1+00 (11)	251°24'	205.15	75	5.0	91°19' [illegible]
STA 2+00 (12)	251°54'	221.99	175'	4.0	80°59'42"
STA 3+00 (13)	252°10'	234.06	276'	5.0	71 32 42
STA 4+00 (14)	252 10'	248.19	374'	4.0	81°43'42"

⊼			
	36°39'30"		
3-2-2A	18°19'36"	195.09'	91 20 30"

5

8 7

↑@ 1C-0-1B

HI = hub #~~1B~~ 1C + 4.08 = 172.64 + 4.08 = 176.72

Line # 4 ~~3~~

		~~255'~~	~~7.18~~	
0+00 36	253°53'	255'	7.18	169.54
1+00 37	249°54'	155'	5.62	171.10
2+00 38	230°07'	59'	4.82	171.90
3+00 39	113°49'	58'	3.58	173.14
4+00 40	94°30'	154'	2.6	174.05

6

↑@ 4-0-5

H.I. = BM + 4.77 = 163.81 + 4.89 = 168.70

Line C	HA		-D-	-R-	Elev.
17+85 29	333°42'		228'	14.31	154.39
23+85 30	299°54'		42'	15.45	153.25
BM	64°48'		203'	4.89	

~~4~~	HA	Elev.	-D-	-R-	VA
LINE 2	~~164°18'~~		~~234'~~	~~15.87~~	
STA 0+00	169°18'	152.81	234'	15.87	~~152.81~~
STA 1+00 21	162°19'	154.16	336'	14.54	~~154.16~~
STA 2+00 22	161°39'	164.65	432'	4.05	~~164.65~~
STA 3+00 23	[illegible]	171.81	530'	6.0	89°00'54"
STA 4+00 24	157°59'	179.70	630'	3.0	88°43'36"

STA 1 on ~~line~~ 2 = 2+00

Line XL-2 Sta XL-2

STA 0+00 25	127°38'		348'	10.82	157.88
STA 1+00 26	149°35'		325'	12.75	155.95
STA 3+00 27	177°32'		368'	14.39	154.31
STA 4+00 28	189°20'		425'	13.28	155.42

7

STA	B.S	H.I	F.S	Elev.	
BM	4.08	167.89		163.81	
TP#1	0.63	158.68	9.84	158.05	
TP#2	13.29	169.64	2.33	156.35	
TP#3	12.29	180.705	1.225	168.415	
TP#4	14.65	194.765	0.59	180.115	
TP#5	5.81	199.96	0.615	194.15	
STA 2	0.845	196.065	4.74	195.22	✓
TP#6	0.825	~~181.83~~ ~~211.95~~	~~15.06~~ 15.81	~~211.125~~	181.005
TP#7	1.29	~~170.52~~ ~~200.64~~	12.60	~~179.35~~	169.29
TP#8	0.345	~~158.535~~ ~~188.765~~	12.33	~~158.19~~ ~~188.31~~	
TP#1	10.19	~~168.255~~ ~~197.685~~	0.47	~~187.495~~	158.065
BM			4.44	163.815	
	Σ 64.245		64.24		

U.S.G.S. Disk "H6"

[Note: Line C
STA 15+85 — assume same elev. as STA 16+00]

Control pt #2 P.K nail in rd.

[Note:
Line 2, STA 1+00 = Line XL-2, STA 2]

STA	B.S.	H.I.	F.S.	Elev.
B.M	5.715	169.525		163.81
Hub # 4	4.04	167.715	5.85	163.675
T.P # 1	3.27	156.205	14.78	152.935
T.P. # 2	5.165	157.555	3.815	152.39
Hub # 5	5.22	160.035	2.74	154.815
T.P. # 3	8.85	162.785	6.10	153.935
T.P. # 4	5.255	165.23	2.81	159.975
T.P. # 5	6.06	166.81	4.48	160.75
Hub # 1	3.225	165.535	4.50	162.31
Hub # 1B	5.96	165.945	5.55	159.985
Hub # 1	3.465	165.77	3.64	162.305
TP # 6	1.55	162.47	4.85	160.92
8+00 L3			4.24	158.23
10+00 "			6.28	156.19
TP. # 7	4.07	161.98	4.56	157.91
12+00 L3			5.0	156.98
14+00 "			3.48	158.50
TP. # 8	3.525	163.515	1.99	159.99
16+00 L3			4.95	158.57
TP # 9	3.38	159.845	7.05	156.465
TP # 10	3.515	156.735	6.625	153.22
TP # 1	14.96	167.855	3.84	152.895
B.M.			4.08	163.775
	87.225		87.26	

U.S.G.S. Disk "H6"

Controll hub # 4

Controll hub # 5

Controll hub # 1

Controll hub # 1B

Controll hub # 1

STA 8+00 Line 3

STA 10+00 Line 3

STA 12+00 Line 3

STA 14+00 Line 3

STA 16+00 Line 3

U.S.G.S. Disk "H6"

8

SECTION 8

SEISMIC REFRACTION SURVEY REPORT

Weston Geophysical CORPORATION

December 5, 1985
WGC - R767

ATLANTIC TESTING LABORATORIES LTD.
PO Box 29
Canton, New York 13617

Gentlemen;

In accordance with the Army Corps of Engineers contract no. DACW33-85-D-0011, Weston Geophysical has performed a seismic refraction survey at Westfield, Massachusetts.

Preliminary profiles have previously been submitted to Atlantic Testing Laboratories, Ltd. This is a formal report of our findings.

Very truly yours,

WESTON GEOPHYSICAL CORPORATION

M. Blackey

Mark Blackey

MB:wpt-0233J1

SEISMIC REFRACTION SURVEY

PROPOSED FLOOD CONTROL DAM

WESTFIELD, MASSACHUSETTS

Prepared for

ATLANTIC TESTING LABORATORIES, LTD.

DECEMBER, 1985

Weston Geophysical
CORPORATION

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION & PURPOSE

A seismic refraction survey was conducted for Atlantic Testing Laboratories, Ltd. at a proposed flood control dam in Westfield Massachusetts. The survey was conducted during the period of November 12 through 15, 1985.

The purpose of this study was to determine the thickness and seismic velocities of the various layers present and to determine the depth to bedrock.

All fieldwork was coordinated through Atlantic Testing of Canton, New York.

2.0 LOCATIONING & SURVEY CONTROL

The area of investigation is shown on the location map included in Figure 1. This map is a segment of the Westfield, Massachusetts United States Geological Survey Topographic Quadrangle Map. The specific lines of coverage are also shown on Figure 2. Vertical and horizontal control was provided by Atlantic Testing.

3.0 METHOD OF INVESTIGATION

The field program consisted of continuous seismic refraction profiling. Seismic spread lengths of 400 and 800 feet were used, depending upon site characteristics. A discussion of the seismic refraction profiling technique is included as Appendix A to this report.

4.0 PRESENTATION OF RESULTS

The results of this survey are presented in tabular form in Figure 1, and as a series of seismic profiles on Figure 2. These profiles show thickness of the various seismic layers and their seismic velocity values.

5.0 MATERIAL IDENTIFICATION

Using seismic data alone, materials can be placed into broad classifications based on the velocity of the seismic wave transmitted through them. Each velocity value does not correlate uniquely with a specific material, but most bedrock as well as overburden types fall within the restricted velocity ranges given below.

5.1 Overburden

The velocity range of a few hundred to less than 1,000 ft/sec is typical for very loose fill materials.

The velocity range of 1,000 to 2,000 ft/sec is indicative of loose, unconsolidated, and unsaturated materials. In the New England area, these materials are often fluvial deposits.

The velocity range of 2,000 to 3,000 ft/sec is usually indicative of an unsaturated overburden material, possibly a coarse gravel or ground moraine type of glacial till.

Seismic velocity values in the range of 3,000 to 4,500 ft/sec are usually representative of a compact type of overburden material such as a relatively dense glacial till.

Seismic velocity values of 4,800 to 5,300 ft/sec are typical for water-saturated fluvial deposits. This velocity range is characteristic of materials which have been developed successfully as municipal groundwater supplies.

The velocity range of 6,000 to 8,000 ft/sec is usually characteristic of dense glacial till.

5.2 Bedrock

Depending upon the degree of weathering, bedrock can have seismic velocity values spanning virtually the entire range of values for overburden; at the lower end of this range, however, the bedrock will have the physical characteristics of overburden.

Seismic velocities in the range of 8,000 to 10,000 ft/sec are commonly indicative of slightly to moderately weathered bedrock which may require at least localized drilling and blasting for excavation.

The velocity range of 12,000 to 12,500 ft/sec at this site is indicative of bedrock which is generally sound and unweathered, and will require systematic drilling and blasting for excavation.

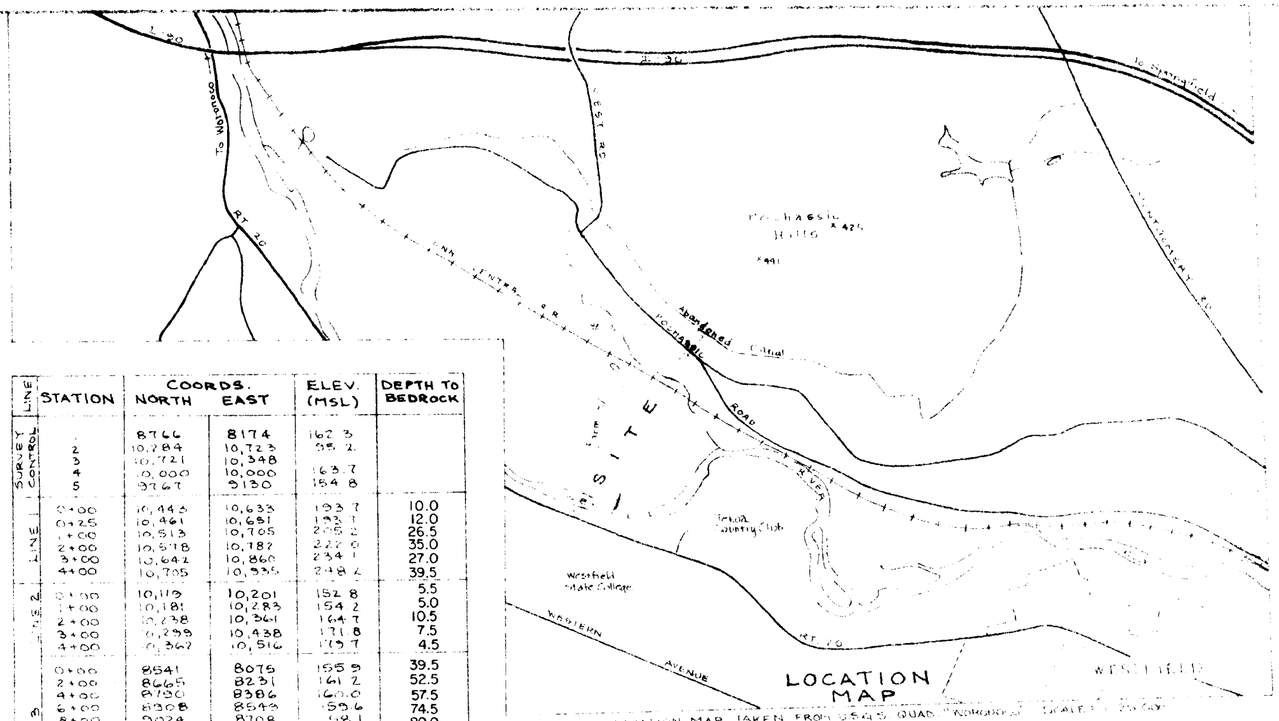
6.0 DISCUSSION OF RESULTS

Bedrock depths up to 80 feet were found along Line 3, on the floodplain of the Westfield River. Shallow rock was observed on the remaining seismic spreads; depths to rock are as shallow as five feet on the left abutment.

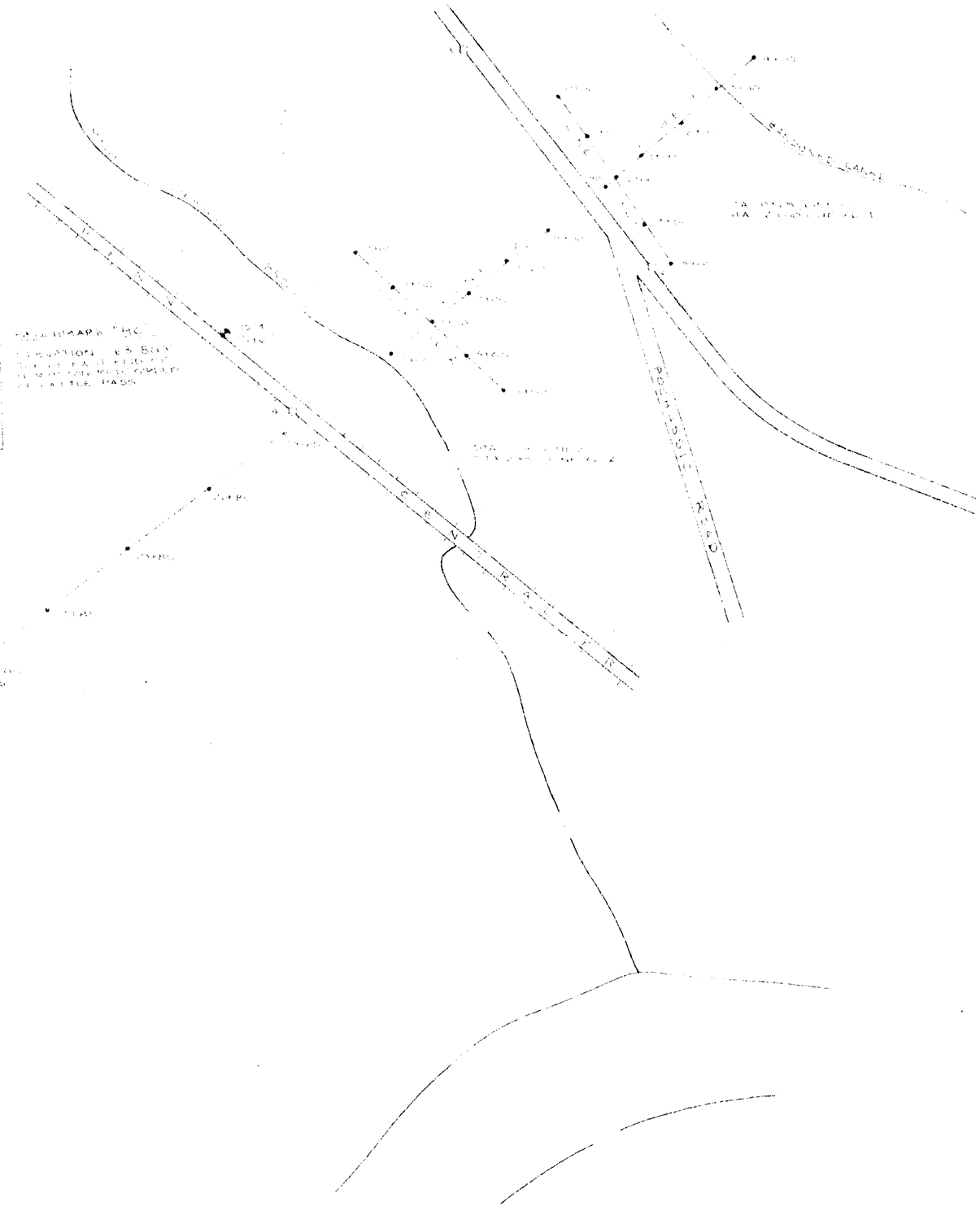
Densely packed gravel at Line 4 resulted in shallow shot holes, necessitating reduction of the explosive charges. Thus, seismic data acquired along Line 4 exhibited lower-energy arrivals, and depths calculated from these data have some uncertainty. Accordingly, the Line 4 profiles are dashed.

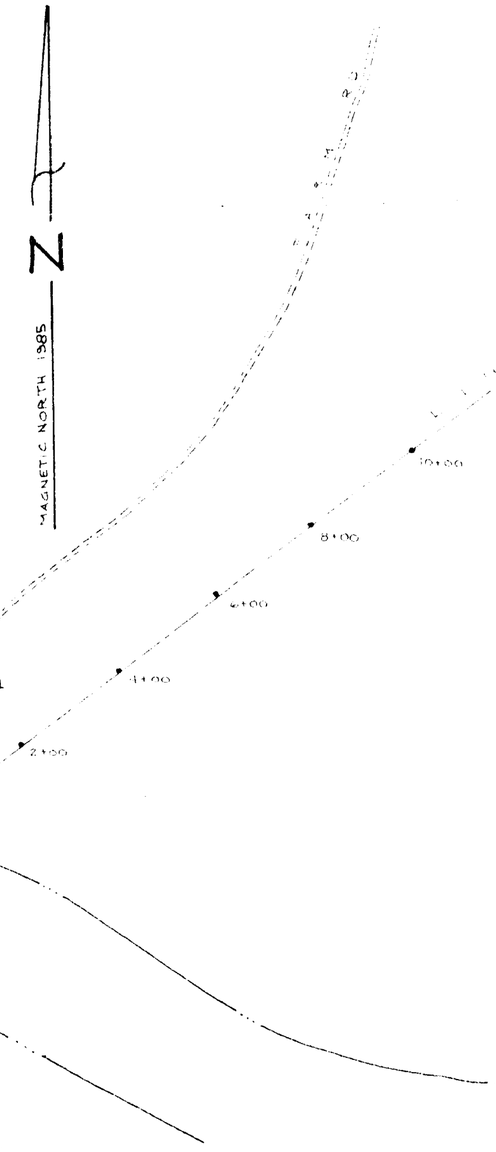
FIGURES

LINE	STATION	COORDS. NORTH	COORDS. EAST	ELEV. (MSL)	DEPTH TO BEDROCK
SURVEY CONTROL	1	8766	8174	162.3	
	2	10,784	10,723	98.2	
	3	10,721	10,348		
	4	10,000	10,000	163.7	
	5	9767	9130	164.8	
LINE 1	0+00	10,443	10,633	193.7	10.0
	0+25	10,461	10,651	193.1	12.0
	1+00	10,513	10,705	205.2	26.5
	2+00	10,578	10,787	222.9	35.0
	3+00	10,642	10,860	234.1	27.0
	4+00	10,705	10,935	248.2	39.5
LINE 2	0+00	10,119	10,201	152.8	5.5
	1+00	10,181	10,283	154.2	5.0
	2+00	10,238	10,361	164.7	10.5
	3+00	10,299	10,438	171.8	7.5
	4+00	10,362	10,516	179.7	4.5
LINE 3	0+00	8541	8075	155.9	39.5
	2+00	8665	8231	161.2	52.5
	4+00	8790	8386	160.0	57.5
	6+00	8908	8543	159.6	74.5
	8+00	9024	8708	158.1	80.0
	10+00	9144	8865	156.7	81.5
	12+00	9263	9025	157.0	76.5
	14+00	9382	9180	158.5	76.5
	15+85	9492	9339	158.6	77.5
	16+00	9500	9351	158.6	77.5
	17+85	9613	9502	156.1	57.0
	19+85	9728	9671	154.6	47.5
	21+85	9841	9831	154.4	35.0
	23+85	9959	9992	155.3	30.5
LINE 4	0+00	8459	7457	175.5	41.0
	1+00	8407	7745	177.1	35.0
	2+00	8352	8069	178.9	34.5
	3+00	8298	8352	172.1	42.0
	4+00	8240	8988	174.1	37.0
LINE 5	0+00	10,629	10,543	208.1	5.5
	1+00	10,546	10,600	198.2	29.0
	2+00	10,461	10,651	193.7	12.5
	3+00	10,375	10,711	196.1	12.0
	4+00	10,292	10,766	203.9	11.0
LINE 6	0+00	10,323	10,134	152.6	5.0
	1+00	10,250	10,207	156.0	7.0
	2+00	10,181	10,283	154.2	5.5
	3+00	10,116	10,361	154.3	5.5
	4+00	10,042	10,423	155.4	4.5



LOCATION MAP TAKEN FROM USGS QUAD "ROMANCE" SCALE 1" = 2000'





• SEISMIC LOCATION POINT
□ SURVEY CONTROL POINT

DRAWN BY	SLA
CHECKED BY	DLD
SCALE	1" = 200'
DATE	Nov 26, 1985
PROJECT NUMBER	CD-007

SEISMIC EXPLORATION AND SURVEY MAP

WESTFIELD RIVER
WESTFIELD MASS.

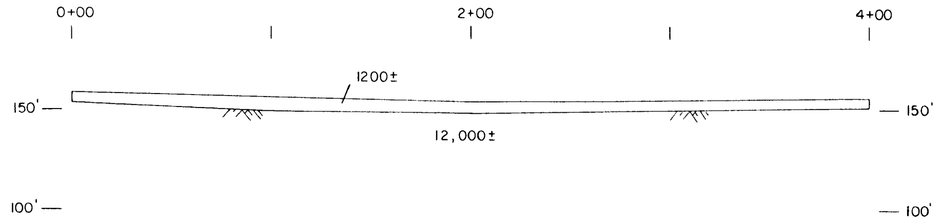
SPENCER E. THEW, P.E./L.S.
PROFESSIONAL ENGINEER - LICENSE / LAND SURVEYOR - LICENSE NO.

SEISMIC REFRACTION SURVEY
PROPOSED FLOOD CONTROL DAM
WESTFIELD, MASSACHUSETTS
prepared for
ATLANTIC TESTING LABORATORIES, LTD.

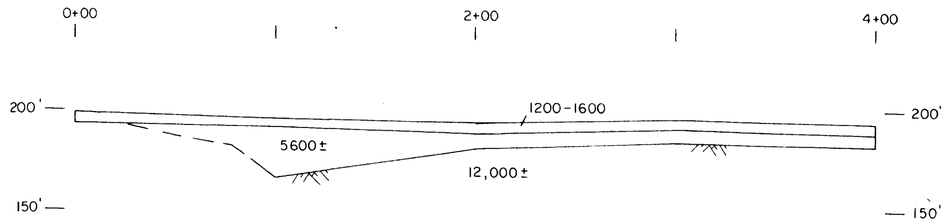
SEISMIC EXPLORATION and SURVEY MAP

WESTON GEOPHYSICAL CORPORATION
DECEMBER 1985 **FIGURE 1**

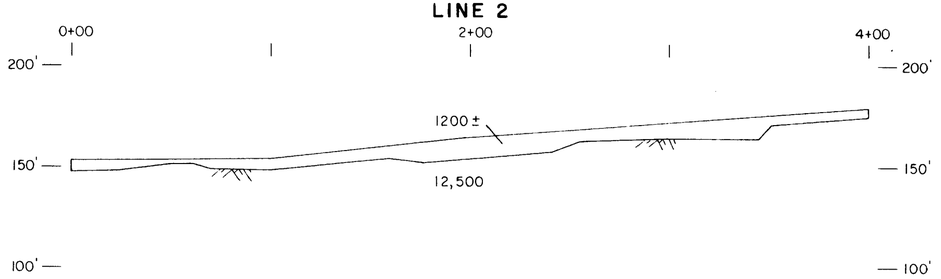
X-LINE 2



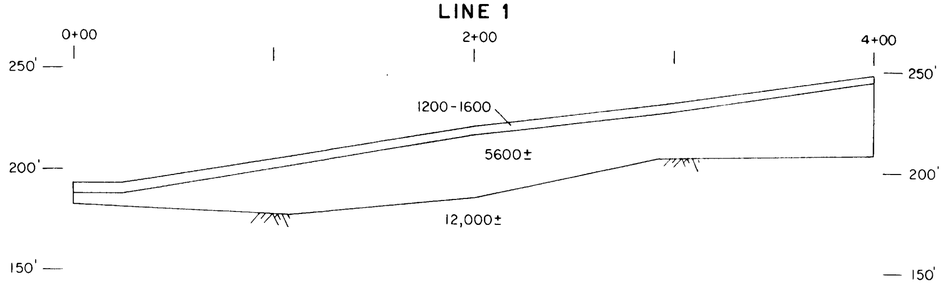
X-LINE 1



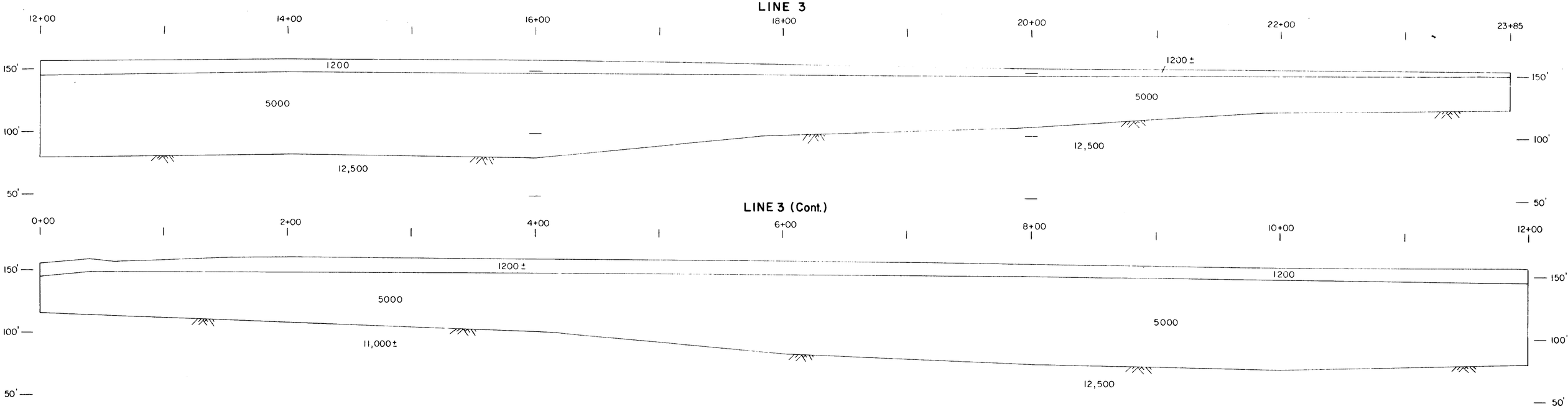
LINE 2



LINE 1



LINE 3



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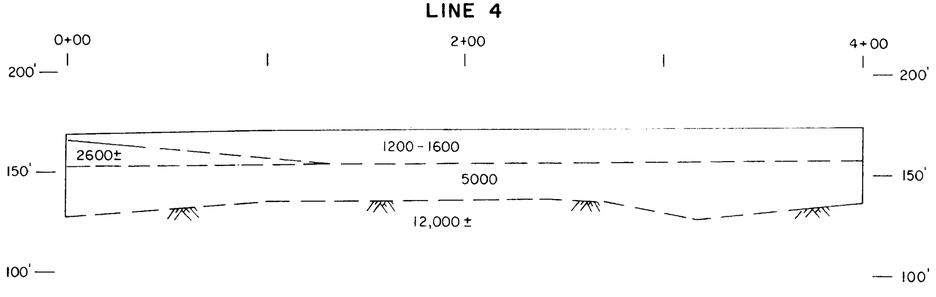
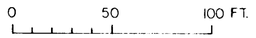




NOTE: SEISMIC VELOCITIES SHOWN ARE IN FEET/SECOND.

SEISMIC REFRACTION SURVEY PROPOSED FLOOD CONTROL DAM WESTFIELD, MASSACHUSETTS prepared for ATLANTIC TESTING LABORATORIES, LTD.	**SEISMIC PROFILES** WESTON GEOPHYSICAL CORPORATION DECEMBER 1985 FIGURE 2

APPENDIX A

SEISMIC REFRACTION SURVEY
METHOD OF INVESTIGATION

GENERAL CONSIDERATIONS

The seismic refraction survey method is a means of determining the depths to a refracting horizon and the thickness of major seismic discontinuities overlying the high-velocity refracting horizon. The seismic velocities measured by this technique can be used to calculate the mechanical properties of subsurface materials [moduli values], as well as for material identification and stratigraphic correlation.

Interpretations are made from travel time curves showing the measurement of the time required for a compressional seismic wave to travel from the source ["shot"] point to each of a group of vibration sensitive devices [seismometers or geophones]. The geophones are located at known intervals along the ground surface, as shown in Diagram A. Various seismic sources may be used, including a drop weight, an air gun, and small explosive charges.

FIELD PROCEDURE FOR DATA ACQUISITION

Weston Geophysical Corporation uses a seismic recording technique of continuous profiling and overlapping spreads for engineering and ground water investigations. The seismic refraction equipment consists of a Weston Geophysical trace amplifier, Model USA780, with either a WesComp II™ [a field computer system developed by Weston], or a recording oscillograph.

Continuous profiling is accomplished by having the end shot-point of one spread coincident with the end or intermediate position shot-point of the succeeding spread. The spread length used in a refraction survey is determined by the required depth of penetration to the refracting horizon. It is generally possible to obtain adequate penetration when the depth to the refracting horizon is approximately one-third to one-quarter of the spread length.

In general, "shots" are located at each end and at the center of the seismic spread, Diagram B. The configuration of the geophone array and the shot point positions are dependent upon the objectives of the seismic array.

As mentioned above, seismic energy can be generated by one or more of several sources.

The seismometer or geophone is in direct contact with the earth and converts the earth motion resulting from the shot energy into electric signals; a moving coil electromagnetic geophone is generally used. This type of detector consists of a magnet permanently attached to a spiked base which can be rigidly fixed to the earth's surface. Suspended within the magnet is a coil wrapped mass. Relative motion between the magnet and coil produces an electric current, with a voltage proportional to the particle velocity of the ground motion.

The electric current is carried by cable to the recording device which provides simultaneous monitoring of each of the individual geophones. The operator can amplify and filter the seismic signals to minimize background interference. For each shot the seismic signals detected by a series of geophones are recorded on either photographic paper or magnetic tape, depending on job requirements. Included on each shot record is a "time break" representing the instant at which the shot was detonated.

INTERPRETATION THEORY

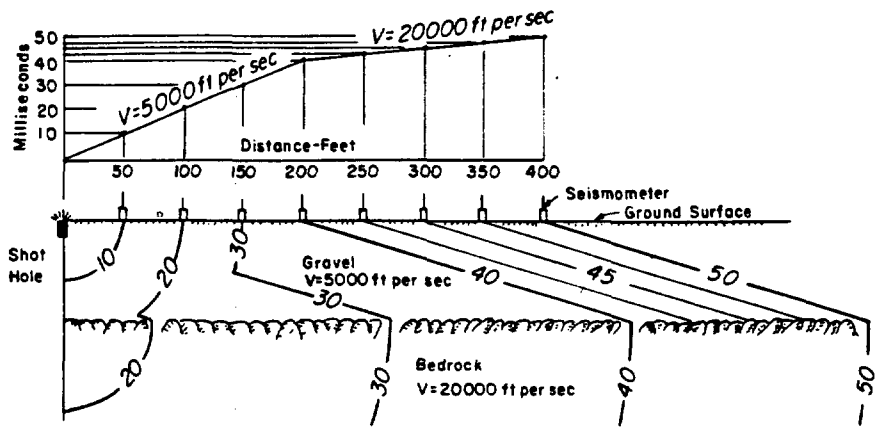
The elastic wave measured in the seismic refraction method, the "P" or compressional wave, is the first arrival of energy from the source at the detector. This elastic wave travels from the energy source in a path causing adjacent solid particles to oscillate in the direction of wave propagation. Diagram A shows a hypothetical subsurface consisting of a lower velocity material above a higher velocity material. At smaller distances between source and detector the first arriving waves will be direct waves that travel near the ground surface through the lower velocity material. At greater distance, the first arrival at the detector will be a refracted wave that has taken an indirect path through the two layers. The refracted wave will arrive before the direct wave at a greater distance along the spread because the time gained in travel through the higher-speed material compensates for the longer path. Depth computations are

based on the ratio of the layer velocities and the horizontal distance from the energy source to the point at which the refracted wave overtakes the direct wave.

Generally the interpretation is by one or more of several methods [W.M. Telford, et al, 1976] ray-tracing, wave front methods, delay times, critical distances. etc. In addition, either a forward or inverse interpretation can be performed using Weston's computer. Since successful refraction interpretation is based on experience, all interpretation of refraction data is performed or thoroughly reviewed by a senior staff geophysicist.

Reference

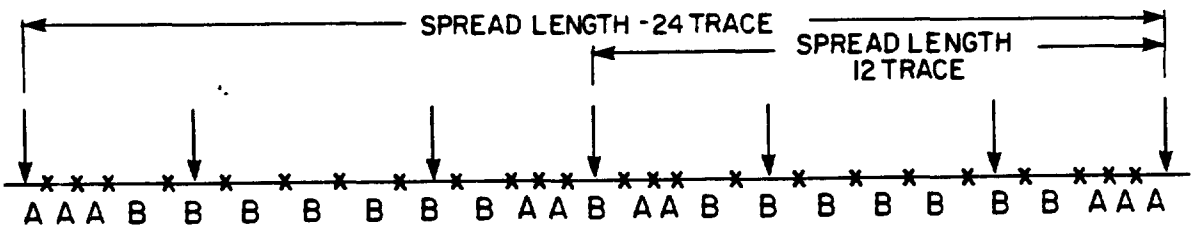
Telford, W.M.; Geldart, L.P.; Sheriff, R.E. and Keys, D.A., 1976, Applied Geophysics: Cambridge University Press.



Plot of Wave Front Advance in Two Layered Problem

Linehan, Daniel, Seismology Applied to Shallow Zone Research, Symposium on Surface and Subsurface Reconnaissance, Special Technical Publication No. 122, American Society for Testing Materials, 1951.

Diagram A



SPREAD LENGTH	GEOPHONE LOCATION	A	B
400' - 24 TRACE or 200' - 12 TRACE		10	20
600' - 24 TRACE or 300' - 12 TRACE		15	30
1000 - 24 TRACE or 500' - 12 TRACE		25	50

LEGEND

↓ = GENERAL LOCATION OF "SHOT" POINT

x = GEOPHONE LOCATION

Geophone Interval-Spread Length Relationship

Diagram B